Numerical simulation towards clarification of control mechanism of nanosecond-pulsed-driven DBD plasma actuator

Report Number: R23EACA58
Subject Category: JSS Inter-University Research
URL: https://www.jss.jaxa.jp/en/ar/e2023/23762/

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Abstract

Flow separation control in fluid machinery is important factor in terms of minimizing its energy loss. In particular, development of an active airflow control technique, that enhances the performance at off-design point, can dramatically improve the performance of fluid machinery. Plasma actuators have been attracted attentions as the novel active airflow control device. In this study, numerical simulations of the flow field around an airfoil controlled by a nanosecond-pulse-driven DBD plasma actuator are conducted in order to clarify its control mechanism.

Reasons and benefits of using JAXA Supercomputer System

To perform the numerical simulation of the flow field around an airfoil controlled by the nanosecond-pulsed-driven DBD plasma actuators, it is required to resolve a time scale of the nanosecond pulsed discharge, which is shorter than that of the flow field. Moreover, the Reynolds number is approximately 100,000, requiring a Large Eddy Simulation (LES) of the flow field. Therefore, using a supercomputer is indispensable to assess the numerical simulation considered in this study.

Achievements of the Year

We confirmed that the separating flow around an airfoil could be attached by applying repetitive pulses. We found that the attached flow was maintained even though the pulse repetitive frequency was reduced after the attached flow was obtained by pulsed discharges with higher frequencies. Since the pulsed discharges with a low frequency fails to modifies from the separated flow to attached flow, this hysterisis effect might be usuful in view of the development of an optimal active flow control law.

Publications

- Oral Presentations

Shintaro Sato, Hibiki Tomie, Naofumi Ohnishi, Numerical simulation of separating airflow control around an airfoil using nanosecond-pulsed discharge, Mechanical Engineering Congress, 2023 Japan, Tokyo Metropolitan University, September 2023

Usage of JSS

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1 - 1024
Elapsed Time per Case	72 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.11

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	2,953,075.57	0.13
TOKI-ST	526.40	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	95.00	0.08
/data and /data2	147,610.00	0.91
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	3.47	0.01

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	21.06	0.01

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.